co-ordinates of right ascension and declination. This the author proceeds to investigate by applying the new method of reduction to Dr. Frank Schlesinger's measures of the Rutherford photographs of the Praesepe cluster. In working out the equations of condition, both the rigid least square solution and the simplification devised by Mr. Dyson are given. From the values of the residuals it appears that determinations of parallax, &c., from photographs, may with advantage be carried out entirely in rectangular co-ordinates, and the results thus published. In addition, the approximate method of solution of the equations of condition is but little inferior to the rigid least square solution. A great advantage of the adoption of this plan would be the tendency to equalise the time of obtaining and reducing the photographs.

TECHNICAL INSTRUCTION IN RELATION TO INDUSTRIAL PROGRESS.[1]

What are the new industrial conditions which we now have to meet?

WE have long known of the enormous progress being made in Germany, especially in those branches of manufacture of the more scientific kinds. Thus, most of the electric plants installed throughout the continent have been made in Germany, and German firms are building practically all the large lighting and traction plants in South America. In steam engineering and in shipbuilding we know how efficient Germany has become. The phrase "made in Germany" was intended to imply that the goods so marked were not equal in quality to British made goods, but the phrase no longer carries this meaning, and it will be remembered that when the *Kaiser Wilhelm der Grosse* made a record passage from New York to Southampton, having beaten the best English record, she sailed into port with large white letters painted on her side, "MADE IN GERMANY." I was in Germany myself just as this happened, and heard the story passed round, to the great amusement of the Germans.

In South Africa the same progress has been made by the Americans, who have supplied most of the machinery used in the South African mines, and the engineers engaged there are nearly all young Americans who have received a good technical training as engineers and electricians. Again, many of the principal electric light and power plants in our own country are equipped throughout by American firms in competition with the best home companies, and erected at our very doors, notwithstanding that the American plant has to be carried so many thousand miles before it reaches its destination.

It is frequently stated that this is owing to our own firms being so full of work that they have orders two years ahead, but the question is whether England has more work than she can do, or whether the rate of production of that work is what it might be if the plant employed in our various manufactories were of a more up-to-date type. In any case it is clear that the higher grades of the metalworking trades are no longer a speciality of this country, but, on the contrary, both America and Germany can compete with us on our own ground.

But there is another direction in which, quietly but surely, a revolution is being effected in methods of manufacture, not only in engineering works of all kinds, but in many industries which have never until recently used machinery, and this revolution is being brought about by the introduction of the American Machine Tool. The characteristics of this machine tool are its high quality, its adaptability to all kinds of special work requiring automatic appliances, and the method of working the tool so as to produce with great accuracy an indefinitely large number of interchangeable parts by working to standard gauges.

To give an illustration of the way in which these changes are being brought about by the introduction of the American machine tool: A few weeks ago I visited the newly-erected machine tool factory of the Ludwig Loewe Co. in Berlin, one of the largest factories of the kind in the world, having cost, I believe, nine million marks to build and equip. The firm was founded in the first place about thirty years ago for the purpose of making sewing machines, but before it could make sewing machines it had to buy American tools with which to make them. Then after a time the American machines required to be repaired, and they had to start a small engineers' shop for the purpose of repairs, and more American tools were purchased to equip the engineers' shop. But this small engineers' shop proved so serviceable and so successful that the sewing machine trade was stopped, and the machine tool instead began to be manufactured. From this beginning a great machine tool business was gradually built up. The tools made were of the newest and most approved American patterns. The head engineer and works' foremen employed were Americans. This business has now reached such enormous dimensions that it includes not only the machine tool works above mentioned, but also Arms and Ammunition works and Electrical Appliance works, the whole employing, I am told, something like twelve thousand men.

From these works are passing out from time to time skilled men with practical experience of up-to-date machine tools, who become foremen in the various works and manufactories, and the result is that, wherever they go, they soon introduce the highest class of machine tools, and rapidly a great change takes place in the amount of business done by the firms. America, as is well-known in engineering circles, is doing an enormous trade on the continent of Europe and with England also in improved machine tools of the highest class.

We have, of course, good machine tool makers in this country, but few, if any, who have made a speciality of one single type of machine tool, as is the case in America, which tool they claim to be the most perfect of its kind, while they leave other types to other manufacturers. By thus confining themselves to one class of tool they greatly reduce the working costs of manufacture as compared with firms who make any and every class and size of tool.

A London Daily recently said, "there is no question that the commercial interests of the United States are growing by leaps and bounds. Europe is beginning to be inundated with American goods, and American firms are getting contracts at the expense of European rivals all the world over. This would not be accomplished except for the fact that American manufacturing plants are maintained by the universal use of high-class machine tools, operated by well-paid workmen, while by far the greater number of shops in this country are equipped with tools many of which are of the most antiquated type."

It is probable the German workshops, generally speaking, are in no sense better equipped than our own. In fact, we have in this country, especially in connection with our great Railway Companies, shops which are probably superior to anything else of the kind in the world, also our textile machinery is superior to that of any other country, but the Germans are waking up to the fact of their deficiencies as compared with the machine tool equipment of the general American manufacturer. They recognise that trade follows the machine tool, and the financiers of Germany appear to be encouraging the rapid introduction of a better class of machines for general works' practice. A similar tendency is at work in this country, and the result is that the industrial conditions are rapidly changing, and a new and more efficient class of men to carry on our mechanical industries is becoming more and more an absolute necessity.

What we require in order to meet these conditions successfully and to maintain our industrial position as a community of metalworkers in competition with our rivals.

It is clear from what has been already said that we need the means of securing a steady supply of skilled machinists and tool makers, with a competent knowledge of up-to-date methods of turning work out, and of the best types of machine tools; men, in fact, who are competent to become, in course of time, leading men and works' foremen.

There are, of course, works' foremen in England second to none in the world, but every one knows, who has any knowledge of works, that such men are singularly scarce, and when a vacancy occurs, extremely difficult to replace. These men are the brain of the workshop, and upon their skill depends very much of the true success of any manufacturing concern. Almost any man in the works could be more easily replaced than the skilled works' foreman.

Incompetent foremen are not only incapable of improving methods of production, but they will not encourage the introduction of new machines, which they themselves have not the ability to understand and use. Such men initiate little, and they continue to demand the same kind of tool and methods that their forefathers used. But the deficiency in the supply of

[1] Abridged from a paper on "Metal Work as a Form of Manual Instruction in Schools," read at a conference of science teachers on January 11, by Prof. W. Ripper, University College, Sheffield.

men of the more competent type is becoming more serious every day, because the demand for skilled mechanicians increases with the introduction of improved machine tools, and the problem is, in what way can we hope to insure a supply of thoroughly well-trained competent machinists.

It will of course be said by a certain class of critics that the workshop is the only place in which such a training must be obtained, but this is not the opinion of some of the best-informed American engineers.

A movement is on foot in America for securing a special training, by the founding of schools for the purpose of training machinists thoroughly from the earliest stages upwards. On this point a most valuable paper has recently been contributed to the American Society of Mechanical Engineers on "The Education of Machinists, Foremen, and Mechanical Engineers," by Prof. M P. Higgins, of Worcester, Mass., U.S.A., in which, after recommending the formation of workshop schools, he says, "America has made a strong beginning as an export nation of high grade machines. There are many evidences of keen interest amounting to surprise and alarm on the part of our European rivals. It is interesting to note their efforts to discover the cause of this sudden uprising of a new and evidently powerful rival in a field heretofore all their own.

"The cause of our supremacy," he says, "has not been altogether the superiority of our high-class engineers, for they also have highly educated engineers. But it has largely resulted from the superior character and make-up of our *mechanics*, which has come from the chance which America gives the workmen, and in the liberal and wise provisions to train American boys, giving each a fair field and open path to rise from one plane to a higher one, as his abilities and circumstances may warrant.

"We must not allow ourselves to rest secure in the belief that our Old World competitors will be slow to discern this cause or slow to profit by the example. Therefore, what more potent steps can we take for our protection than to keep this path open from the bottom, and to better our methods all the way up through the successive stages?"

In what way may the schools help to more effectually prepare our youths for the task which lies before them?

The Elementary School.—I begin at the elementary school because the problem before us is one which can only be solved by laying a good foundation at the very beginning, and proceeding upwards by a properly organised system of training towards the result which we desire to obtain.

Our British system of elementary school training is probably equal to that of any country in the world, but we have to regret the very early age at which the majority of boys pass away from the influences of the school. This is in part due no doubt to the feeling on the part of parents, especially of the lower classes, that after having passed the ordinary standards there is no necessity for any further stay at school, as the subjects taught are assumed to have little or nothing to do with the immediate requirements of life outside the school.

The opening in many large centres of Higher Grade Schools, in which pupils who have reached the higher standards may receive instruction at low fees, in science and in manual work, has been generally productive of much good, by retaining in the school pupils who would otherwise have left at an earlier age; and in these Higher Grade Schools pupils of exceptional ability, as tested by the ordinary system of examinations, have been selected, and in many cases specially trained, for scholarships or for examinations admitting them to the universities. But an idea is beginning to dawn upon us that perhaps, after all, there may be, among the very large majority of boys who are never among those selected to receive any special training to pass university examinations, and who have no special aptitude in the direction of acquiring book knowledge, much real ability in other directions, in fact, that they may be, as it were, a kind of unworked mine of possibilities and resources.

Hitherto they have been looked upon as the wasters of the school, but it is almost certain that the great inventors and mechanicians of our time have not usually come from the class of boys who are looked upon as the most successful students. Usually the "clever boy" is the one who, by his ability, in the particular direction by which the schools measure ability, succeeds in escaping from the workshop and in doing, as he would consider, better for himself by obtaining other employment.

Every Higher Grade School in which work is carried to the extent of providing school laboratories for, say, chemistry and physics, which, by the way, is a very good and necessary provision, should provide also an alternative course in a school workshop for the type of boy well known to teachers whose tendencies are more mechanical than scientific, who would be likely to make much more progress if trained in a workshop than in a chemical laboratory; and who would certainly pay for such training.

Every teacher who has had experience with the teaching of science to boys knows that the class consists of two distinct types; first, those who are fitted by careful training to become successful students, and to take a more or less high position in public examinations, who in fact are aiming at passing some examination as a means to their future progress; and secondly, those who have no prospect of such success, and whose future success will depend, if they succeed at all, upon other qualifications.

Now this latter class includes the majority of the pupils. They contain also the class from which will be drawn in the future the workers, and in some cases the leaders, in our industries, and these boys have, equally with the other boys, a reasonable claim upon all that the school can do for them to prepare them for their future. To meet then the case of these boys the workshop course should be an altogether different course from that hitherto provided. It should be equipped with as much care and as much completeness in its way, for the purpose of training this type of boy, as is the chemical or physical laboratory, and the educational value of such training need be in no sense inferior to that of any other course of study.

It is assumed that boys in such a school have already done a woodwork course, and if so they would here receive an iron-work course in a workshop supplied with a good selection of tools, including some small but good types of machine tools driven by a gas engine or electric motor. The effect of providing such a course of instruction would be to select, by a natural system, the type of boy likely to profit by the training received, and to retain these boys for a much longer period than would otherwise be possible. But the success of such school workshops would depend largely upon the course of instruction given, and upon the quality of the teacher giving it. The course should include practical work in the shops, the arithmetic of machines, geometry, machine drawing and design, and elementary applied mechanics. Each of these subjects is capable of indefinite extension, but it is of great importance that the early teaching should lay a good foundation upon which the future may be built, and that nothing should be learned which will afterwards require to be unlearned.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is announced that a copy of the charter and statutes which are to govern the new University of Birmingham, has been laid on the table of the House of Commons. This contains a list of honorary and other officers covered by the terms of the charter, but only three persons are mentioned who have been definitely appointed to positions in the new University. The first Chancellor will be Mr. Chamberlain. No name is associated with the office of Principal, which is to be a Crown appointment, made through the Lord President of the Council, but the Vice-Principal nominated is Dr R. S. Heath, who has been acting Principal of Mason University College. The appointment of the first Dean of the Faculty of Medicine has been conferred on Dr. B. C. A. Windle, F.R.S.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 7, 1899.—"Gold Aluminium Alloys." By C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.

The freezing point curve for mixtures of gold and aluminium consists of seven branches, each branch corresponding to equilibrium between liquid and the first solid which forms as the system cools. Seven substances can also be detected by a microscopic examination of the solid alloys. They are gold, Au_4Al, Au_5Al_2 or perhaps Au_8Al_3, Au_2Al, a body which is probably $AuAl$, Roberts-Austen's purple $AuAl_2$, and aluminium. With the